Bugs on the brain: diet and the microbiome in mental health

Ruth Harvie NZRD, PhD Candidate, University of Otago, NZ

Sandhu 2017
Contents

• What is the microbiome?
• What does it do?
• The role of the microbiome in mediating the effect of food on the brain-gut axis
• The role of the microbiome in nutrient metabolism
  • Tryptophan
  • Fructose/ sorbitol
• Challenges of researching the diet, microbiome and mental health relationship
Ecosystem = an Ecological system;  
= A community and its physical environment treated together as a functional system.

- Domain level differences (taxonomic tree)
- 1000+ species identified
- Interdependence
- Functional redundancy
- Effect of one member influenced by the community as a whole
- Each individual’s GI microbiome is unique
Other “omics”

• Metagenomics – measures the microbial genes in the sample
• Transcriptomics – measures what is being transcribed into mRNA
• Proteomics – measures what was translated
• Metabolomics – what was produced
  • Fecal or urine
Gastrointestinal microbiomes

Stomach: 0-10^2 CFU/ml
Duodenum: 10^2 CFU/ml
Jejunum: 10^2 CFU/ml
Distal ileum: 10^7-10^8 CFU/ml
Colon: 10^{11} CFU/ml
Mouth: 10^8 – 10^9 CFU/ml
Proof of the effect of the microbiome on the mind

• Germ free animals have ↑ anxiety levels

• Fecal microbiota transplants (animal models)
  • Microbiome of IBS patients with anxiety
    • ↑ anxiety-like behaviours
    • DePalma G et al. Sci Transl Medicine 2017;9

• Effect of probiotics on anxiety

Ingestion of Lactobacillus strain regulates emotional behavior and central GABA receptor expression in a mouse via the vagus nerve

Javier A. Bravo1,*, Paul Forsythe1,*, Marianne V. Chew9, Emily Escaravage8, Hélène M. Savignac2,3, Timothy G. Dinan4,5, John Bienenstock1,6,7, and John F. Cryan1,2,8,9

1Laboratory of NeuroGastroenterology, Alimentary Pharmabiotic Centre, School of Pharmacy, and Departments of Psychiatry and 2Anatomy, University College Cork, Cork, Ireland; The Michael Brain-Body Institute, St. Joseph’s Healthcare, Hamilton, ON, Canada L8N 4A8, and Departments of 3Medicine and 4Pathology and Molecular Medicine, McMaster University, Hamilton, ON, Canada L8S 4L8
Participants underwent functional magnetic resonance imaging before and after the intervention to measure brain response to an emotional faces attention task and resting brain activity.

Four-week intake of an FMPP by healthy women affected activity of brain regions that control central processing of emotion and sensation.
High fructose corn syrup

Metabolites:
- ↓ indole-3-aldehyde (neuroprotective)
- ↑ IPA (neuroprotective)
- ↑ quinolinic acid (neurotoxic)

- Displaces other substrates for fermentation (e.g. tryptophan)
- Blooming of less beneficial bacteria

Mediates food portion uptake

Displaces other substrates for fermentation (e.g. tryptophan)

Blooming of less beneficial bacteria
Spore forming bacteria

metabolites

α-tocopherol
butyrate
cholate
dehydrocholate
p-aminobenzoate
propionate
tyramine

Challenges for research

• Complexity and variation in the microbiome
  • Requires large sample size
  • Cost
  • Cost++++ if we measure the metagenome and metabolome

• Obtaining accurate dietary information

• Lack of standardisation in wet lab techniques and analysis

• Developing multi-disciplinary collaborations encompassing the required skill sets
Research on the horizon

• Sarah Dash has recently completed a PhD at Deakin University in Melbourne, Australia
Conclusion

• The microbiome mediates the effect of food on the brain gut axis (including mood) by
  • Producing metabolites (neurotransmitters)
  • Metabolites affecting cells which then release other chemicals

• Personalising the nutritional management of mental health through algorithms developed incorporating features of the microbiome offers potential

• **BUT** developing these tools and implementing them will be challenging and costly
Acknowledgements

• Associate Prof Michael Schultz (&) Dunedin School of Medicine
• The Canadian centre for human microbiome and probiotic research and the labs of Asst Prof Jeremy Burton, Prof Gregor Reid, Prof Greg Gloor
More information

• https://www.youtube.com/watch?v=awtmTJW9ic8